

4509531-1

NE/Witt

SYNTHESIS AND CHARACTERIZATION OF InTIP AND InTlAs

GRANT NO. F49620-96-1-0001

FINAL REPORT
Feb. 28, 1998

C. R. Abernathy

Rhines Hall
Department of Materials Science and Engineering
University of Florida
Gainesville, FL 32606

REPORT DOCUMENTATION PAGE

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information to the Office of Management and Budget, Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and

ad, and completing and services, Directorate for I3.

0147

1. AGENCY USE ONLY (Leave blank)			2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
			Final 15 Feb 96 to 14 Feb 99	
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS	
Synthesis and Characterization of InTlP and InTlAs			61102F 2301/EX	
6. AUTHOR(S)			8. PERFORMING ORGANIZATION REPORT NUMBER	
Professor Abernathy				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)			9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	
University of Florida 205 Grinter Hall Gainesville, FL 32611-5500			AFOSR/NE 801 N Randolph Street Rm 732 Arlington, VA 22203-1977	
11. SUPPLEMENTARY NOTES			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
			F49620-96-1-0001	
12a. DISTRIBUTION AVAILABILITY STATEMENT			12b. DISTRIBUTION CODE	
APPROVAL FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED				
13. ABSTRACT (Maximum 200 words)			<p>The purpose of this program was to study the synthesis and material properties of InTlP and InTlAs for IR Applications</p> <ol style="list-style-type: none"> 1. Growth and stability of InTlP and InTlAs 2. Doping of InTlP 3. Junctions 4. Interfacial Control 	
14. SUBJECT TERMS			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT		18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED		UNCLASSIFIED	UNCLASSIFIED	UL

Page 1

SYNTHESIS AND CHARACTERIZATION OF InTlP AND InTlAs
GRANT NO. F49620-96-1-0001
University of Florida

1.0 Objectives

The purpose of this program was to study the synthesis and material properties of InTlP and InTlAs for IR applications. The tasks are described in the following list.

1. Growth and stability of InTlP and InTlAs

Initial growth experiments will be conducted using elemental Tl and PH₃ or AsH₃. Layers deposited on (100) semi-insulating InP or undoped InAs substrates will be characterized by Nomarski optical microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), secondary ion mass spectroscopy (SIMS) and Hall effect measurement. Powder x-ray diffraction (XRD) and 5-crystal XRD will be used to determine lattice constant as a function of Tl content for both materials. Growth parameters such as V/III ratio, Tl source and growth temperature will be optimized with respect to structural and electrical quality. In particular, the maximum Tl content which can be obtained without inducing nucleation of metallic Tl droplets will be determined. The relative thermal stabilities of the ternary alloys will be determined as a function of Tl content by monitoring the surface structure and desorption products as functions of temperature and group V flow.

2. Doping of InTlP

The alloy system which yields the most promising properties for use as an IR material as determined from Task 1 will be investigated further by examining the electrical behavior of various impurities. Both unintentionally and intentionally doped samples with various Tl mole fractions will be investigated with variable temperature Hall measurement, to determine the activation energies of intrinsic impurities or defects, and SIMS and AES, to attempt to correlate the electrical centers with impurity species or stoichiometric variations. Results will be compared with theoretical predictions of impurity levels calculated at SRI. Sn, Te and Si will be explored as n-type dopants and Mg will be investigated as a p-type dopant. Ohmic contact resistances using AuGe and TiPtAu will also be determined as a function of doping level.

SYNTHESIS AND CHARACTERIZATION OF InTIP AND InTlAs
GRANT NO: F49620-96-1-0001
University of Florida

3. Junctions

Once controllable n- and p-type doping and acceptable Ohmic contacts are established, junction quality will be evaluated. Diode characteristics of homojunctions of various Tl mole fractions will be evaluated first followed by similar experiments in InTIP/InP or InTlAs/InAs heterojunctions. SIMS analysis will also be performed in order to determine dopant abruptness and electrical quality.

4. Interfacial Control

The ability to reduce strain and/or dislocation densities in the InTIP through the use of graded $In_{1-x}Tl_xP(As)$ layers and InTIP(As)/InP(As) superlattices will be investigated. Films will be characterized using the same techniques as described previously. Interfacial abruptness will be optimized by examining quantum wells grown under various conditions with TEM and PL. The optimum interface will be achieved by optimizing the switching sequence and growth interruption time. Thermal stability will be evaluated by annealing the structures both in-situ and ex-situ, using rapid thermal annealing, and characterizing the layers with TEM and XRD. Diffusion studies in both homojunctions and heterojunctions will be studied using similar annealing and characterization. In these structures, SIMS and C-V profiling will be used to determine the carrier concentration profiles for correlation with the matrix and dopant distributions.

2.0 Growth of Tl-Containing Phosphides

It was determined that low growth temperatures are needed to produce material which contains Tl. Under no circumstances could a phase containing In, Tl and P or Tl and P be formed during attempted epitaxy. Depending upon growth temperature, either a defective In structure was obtained with no evidence of Tl incorporation or, at temperatures less than 400°, an InP matrix with Tl droplets dispersed throughout. Attempts to deposit TIP resulted in formation of Tl droplets atop the InP substrate. For both the Tl-P and In-Tl-P attempts, exposure to air resulted in rapid oxidation of the metallic Tl as determined by SEM, EMPA (electron microprobe analysis) and XRD.